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New Data Link Genetics, Ecology, Researchers Say

International team opens new research field of ecosystem genetics

By Charlene Porter
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Researchers tend to one of several experimental "common gardens" of cottonwoods on the Weber River in Utah. (Photo courtesy of Northern

Washington -- Scientific teams in the United States and Australia are discovering genetic links between plants and animals that share the same ecosystem, and they predict the work will open a new era in evolutionary biology – a biology subfield concerned with the origin of species and species' changes over time.

The teams found the genetic inheritance of an individual species in a biologic community not only determines the characteristics of that species but also affects the genetic characteristics that will be inherited in successive generations of surrounding species.

"We all know that sons and daughters carry traits that are passed on to them from their mothers and fathers," researcher Tom Whitham, professor of biological sciences at Northern Arizona University (NAU) told the *Washington File*. "We've been able to quantify the same the sort of heritability in terms of the community and the ecosystem."

This finding gives new depth to the term "web of life," said Whitham, who led a team that included scientists with diverse specialties in ecology, forestry, plant science and entomology.

The discovery starts with the cottonwood tree, a variety common to the southwestern United States. It is what researchers call the foundation species in a riparian habitat – clusters of trees, shrubs, plants, insects and microbes that comprise riverside ecosystems in the arid region.

The cottonwood produces tannins – a substance widely found throughout the plant kingdom. Tannins are an astringent, whitish or yellowish substance that the plant produces to protect itself in various ways. Just as two family members have different physical

characteristics, individual cottonwoods produce different levels of tannins.

Tannins affect the decomposition rate of cottonwood leaves, which affects the fertility of soils, which affects the microbes in the soil, which affects insects that live in the soil, which affects the birds that live on the insects – right up the food chain.

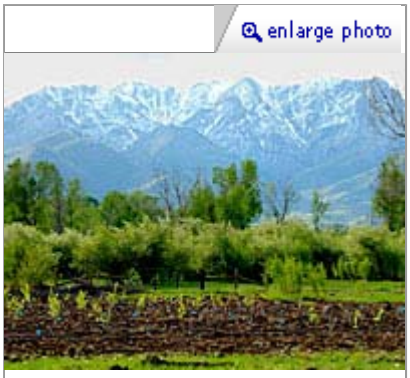
So the genetic inheritance of the one foundation species (its genotype) can affect the biologic structure (the phenotype) of all other species in the system, according to the work published in two technical journals in recent months.

The research is funded by a grant from the U.S. National Science Foundation (NSF) and has involved more than 50 scientists from the United States, Canada and Australia.

INTERNATIONAL COMMUNITY GENETICS RESEARCH

The Australian group, led by Brad Potts at the University of Tasmania, has established the same genetic linkage between species, studying an ecosystem in which the eucalyptus tree is the foundation species.

“Because Australia has a very different evolutionary history than North America,” Potts said in an e-mail interview with the *Washington File*, “studies of an Australian eucalypt are important for understanding the overall generality of extended phenotypes of foundation species and have important implications for maintaining biodiversity.”



An experimental forest on the Weber River in Utah, where an NAU-led research team is studying the genetic basis of ecosystem processes.

The eucalyptus with which Potts and his team are working is a dominant tree in many Australian forests and a major hardwood plantation species in some regions, “making results of worldwide interest,” he said.

Potts and Whitham discovered their common interest in the field of community genetics in 1989, and have been collaborating ever since.

THE IMPLICATIONS

The principles of ecosystem genetics have been proven in observations and experiments in biologic communities surrounding the cottonwood trees, Whitham said.

Future research is needed to determine how commonly this interrelationship among species occurs in other biologic communities, and whether ecosystem genetics is a phenomenon common throughout the natural world. Acknowledging that further work needs to be done, Whitham said the findings are sure to bring a new dimension to ecosystem science.

“Here we have a field that’s never had a genetic perspective, and so [this research] almost has to change the way we view things because the genetic linkages are there in a way that we never appreciated before,” Whitham said, speaking from NAU’s Flagstaff, Arizona, campus.

The NAU-led research team also is working with the U.S. Bureau of Reclamation in land conservation and species preservation projects in the American Southwest. Genetically diverse stands of cottonwood trees are being cultivated in an effort to create habitat that will support a broader array of bird and insect species.

Whitham said the findings on ecosystem genetics also are likely to bring new insights to science’s understanding of how broadly human activities – such as fire, urbanization, climate change, and agriculture – all affect entire biologic communities.

“They all have the potential to favor one species over another, or specific genotypes within a species over one another,” he said. “As these genotypes shift in response to all of these changes or one or more of these changes, there can be a genetic ripple effects that go throughout the whole community and ecosystem.”

Publication of these findings have had a ripple effect of their own, Whitham said. Members of his team have been contacted by researchers in an array of disciplines who are interested in pursuing the work.

Inquiries have come from countries as biologically dissimilar as Sweden, South Africa and Indonesia, Whitham said, and exploratory talks are under way to launch related experiments in other countries.

Whitham welcomes the opportunity for other researchers working in diverse environments to provide further evidence that ecosystem genetics is a phenomenon occurring throughout the natural world.

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